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Fossil Endocranial Cast of *Desmana kormosi* SCHREUDER (*Insectivora, Mammalia*) from the Pliocene of Poland

(Pp. 37—44, pls. I—V, 1 text-fig.)

Kopalny odlew mózgu *Desmana kormosi* SCHREUDER (*Insectivora, Mammalia*) z pliocenu Polski

Ископаемый отлив мозга *Desmana kormosi* SCHREUDER (*Insectivora, Mammalia*) из плиоцена Польши

Abstract. The authors give a description of a natural fossil endocranial cast of *Desmana kormosi* SCHREUDER, 1940 from the Pliocene fauna of Węże in Poland. They compare this cast with the brains of the two extant species of this subfamily: *Galemys pyrenaicus* GEOFFROY, 1811 and *Desmana moschata* (L., 1758). The brain of the fossil species resembled the brain of the former in size and that of the latter in proportions.

INTRODUCTION

This paper is devoted to describing a natural endocranial cast of *Desmana kormosi* SCHREUDER, 1940. This is a member of the subfamily Desmaninae, which in turn belongs to the family Talpidae. Numerous species of this subfamily, known from many localities of fossil faunae, lived throughout Europe in the Pliocene and also in North America for a short period. The Ice Age reduced their distribution gradually to two relict regions, situated at the borders of the area that they had inhabited, and the isolation brought about their differentiation into two species, usually placed in two genera, the Pyrenean water-mole *Galemys pyrenaicus* GEOFFROY, 1811, now inhabiting southern France and northern Spain and Portugal, and the Ukrainian water-mole *Desmana moschata*

(L., 1758), larger than the previous one, common in the basin of the Volga and less numerous in the basins of the Don, Oka and Ural.

The specimen described comes from a Late-Pliocene locality at Węże near Działoszyn, where a large number of bones of small and large mammals and other terrestrial vertebrates have been found in a vertical cave. They fell into the cave by accident or became preys to the owls living in it. The skull under study is the only one, preserved together with its delicate brain-box, representing this insectivore group in the materials obtained from the Polish localities of fossil faunae.

Table I

Measurements of the rostral portion of the skull in the fossil Desmaninae from Węże (in mm)

	A	B	C	$\frac{B}{C}$
Desmana nehringi	7.9	13.3	8.9	150
Desmana kormosi	6.4	10.0	8.1	123
specimen with endocranial cast	6.0	8.1^{+}	8.0	101

A — width of rostral portion at the height of P^4, B — greatest width of rostral portion, C — length of rostral portion, from P^4 to M^3, + incomplete measurement owing to damage to specimen.

At Węże the subfamily *Desmaninae* was represented by two species: a larger form, *Desmana nehringi* Kormos, 1913, and a smaller one, *Desmana kormosi* Schreuder, 1940 (Rzebik-Kowalska, 1971). Although the skull is damaged and wanting in dentition, its small size and the relatively slender shape of its rostral part, which is less distended in the region of M^1 and M^2, refer it beyond question to the smaller species, *Desmana kormosi* (Table I, Text-fig. 1).

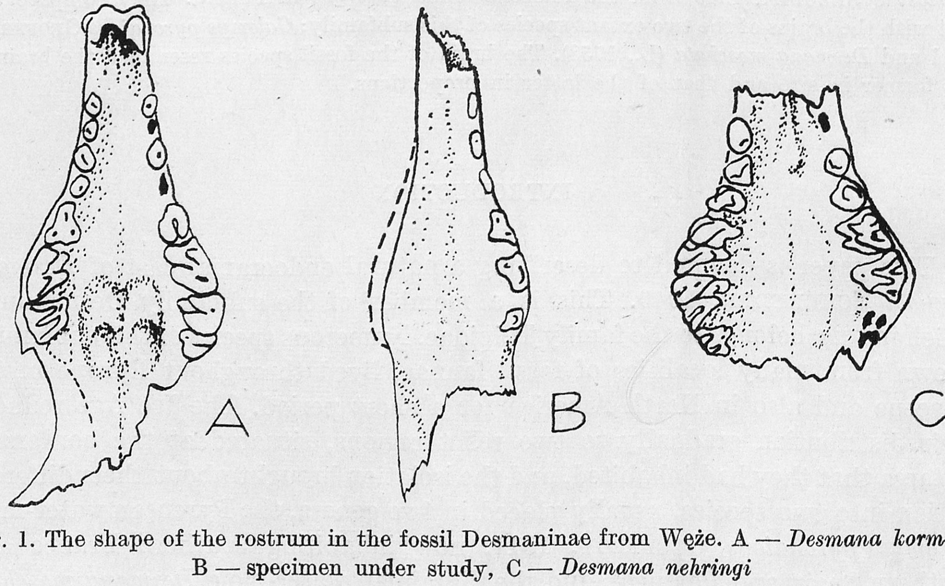


Fig. 1. The shape of the rostrum in the fossil Desmaninae from Węże. A — *Desmana kormosi*, B — specimen under study, C — *Desmana nehringi*

This species was described for the first time from Hungary (SCHREUDER, 1940), up to now it has also been recorded from Germany (HELLER, 1954) and from three localities in Poland: Węże I and Rębielice Królewskie I and II (KOWALSKI, 1960; RZEBIK-KOWALSKA, 1971).

The morphology of the brain of a few modern insectivore species which systematically stand close to those discussed here is known owing to the works by ROSE (1912), CLARK (1928, 1932), LECHE (1905) and SMITH (1902). None of these authors dealt with the morphology of the brain of a member of the Desmaninae. The first anatomical description of the brain of *Galemys pyrenaicus* was given by STEPHAN and BAUCHOT (1959) and BAUCHOT and STEPHAN (1967). The brain of *Desmana moschata* has not hitherto been described, there are no descriptions of the brain of fossil water-moles, either.

The authors thank Dr. Lucjan SYCH for taking photographs and preparing their copies for the present paper.

MATERIAL AND METHOD

The material consists of one fossil endocranial cast of *Desmana kormosi* from the Pliocene of Węże. The specimens used for comparison were obtained from individuals of the species now inhabiting the Pyrenees and the Volga region, one specimen of either species. In the case of the Pyrenean specimen the brain removed from the skull was used, whereas an endocranial cast was made for the specimen from the Volga region.

An adult specimen of *Galemys pyrenaicus* was fixed in alcohol. For the removal of the brain the skull containing it was left in 70% alcohol for some time so that the tissue should be fixed better. The fragility of the brain tissue caused that the paraflocculus broke off from the petrosal bone on the left side. This brain was used, among other things, for taking measurements.

An endocranial cast of *Desmana moschata* was performed by filling the brain-box with a plastic substance, using a syringe for this purpose. The bones of the skull were next removed in the same manner as for the removal of the brain.

The fossil „brain" enclosed in a calcite concretion was prepared by solving the concretion using a weak solution of hydrochloric acid alternately with acid sodium carbonate as a substance inhibiting the action of the acid if necessary. On account of the very great fragility of the material we failed to uncover the bottom of the brain, which was covered by a thin layer of mineralized bone.

The fossil „brain" of *Desmana kormosi* or, strictly speaking, its cast formed by the filling of the brain-box with mineral substances, shows more details preserved than the artificial endocranial cast of the modern specimen produced for comparative purposes does. This is a common fact (e. g., STEPHAN and BAUCHOT, 1967), because during natural fossilization the process of filling advances slowly and, consequently, the details are rendered more pronounced.

Owing to the consistence of plastics used and their relatively short time of setting, some details remain unrendered on the artificial cast. Another sort of unavoidable methodic defect is the slight shrinkage of the brain after its removal and fixation in alcohol or formalin. This makes it necessary to apply corrections for the measurements.

DESCRIPTION

Fossil specimen

Menings and vessels of the brain. The impressions of the dura and pia matters and major blood-vessels can be seen deep in the rhinal fissure and on the cerebral hemispheres of the cast. A fairly distinct pattern of blood-vessels is imprinted in the region of the pyriform lobe and in the depression of the rhinal fissure (Pl. I and II).

Fissures of the hemispheres. The rhinal fissure, which is the only one, occurs between the olfactory bulb and pyriform lobe on one side and the neocortex on the other side and runs in a horizontal plane (Pl. Ib).

The olfactory bulbs extend to the front (Pl. Ia).

The cerebellum is small compared with the size of the cerebral hemispheres and does not project beyond their posterior margin. The fissures of the cerebellum are single and few in number. The worm of the cerebellum runs downwards without turning to the rear (Pl. I a).

Comparison with modern specimens

The cerebral hemispheres of *Galemys pyrenaicus* (Pl. IV—V) are somewhat slenderer than those of the fossil specimen and *Desmana moschata* (Pl. III). The frontal area of the hemispheres is flattened in all the three specimens. The olfactory bulbs extend to the front and in the fossil specimen and *Desmana*

Table II

Measurements of brain in desmanine species examined (in mm)

	Desmana moschata	*Desmana kormosi*	*Galemys pyrenaicus*
Length of hemispheres without olfactory bulbs	17.3	13.4	15.2
Greatest width of hemispheres	20.0	15.1	15.3
Length of hemispheres including cerebellum	19.0	15.0	16.9
Length of olfactory bulbs	4.0	2.5	1.8
Greatest width of olfactory bulbs	6.0	7.8	6.5
Greatest height of hemispheres	10.5	10.0	10.6

Table III

Indices of brain measurements of desmanine species under study (round values)

	Desmana moschata	*Desmana kormosi*	*Galemys pyrenaicus*
$\frac{\text{Hemisphere length}}{\text{Greatest hemisphere width}} \cdot 100$	87	88	99
$\frac{\text{Olfactory-bulb length}}{\text{Hemisphere length}} \cdot 100$	23	19	12
$\frac{\text{Greatest height}}{\text{Hemisphere length}} \cdot 100$	61	75	69

moschata have greater proportions in relation to the cerebral hemispheres (cf. Table IIII). The side view of the brain shows a strong dorsal curvature in all the species under study. The worm of the cerebellum descends at a right angle towards the medulla.

Each of the specimens shows somewhat different morphological details. The measurements and proportions of particular parts of the brain are given in Tables II and III.

The greatest length and width measurements of the hemispheres were ascertained in the endocranial cast of *Desmana moschata*. On the basis of the measurements and proportions of the measured parts presented in the tables it may be stated that this specimen is larger than the other two, whereas the fossil specimen resembles *Galemys pyrenaicus* in size.

DISCUSSION

The endocranial cast reflects the sculpture of the brain including the dura matter and major blood-vessels, the course of the cranial nerves and occasionally the sutures of the cranial cbones. All the cerebral fissures are not marked on the cast and the smooth surfaces of the cast need not necessarily indicate cerebral surfaces devoid of fissures. Neither does the relief of the cranial bones always reflect the fissures actually existing under it. In this connection the comparison of casts with a real brain is a far-reaching simplification. The examination of the proportions and measurements of particular parts and their comparative study, however, produce some possibilities to draw more general conclusions.

The olfactory centres of the 1st and 2nd order are generally very well developed in the Insectivora, which is evidenced, among other things, by the well-developed allocortex (both palaeocortex and archicortex together). The allocortex is separated from the rest of cortex by a sulcus, called the rhinal fissure (sulcus palaeoneocorticalis — Rose, 1912), which differs in length. According to Stephan and Bauchot (1959), *Neomys*, which is adapted for

aquatic way of life in a great measure, shows a reduction of the olfactory system and enlargement of the neocortex. These authors compared also the genera *Talpa* and *Galemys* in this respect. In *Talpa* the olfactory centres are very well developed (the rhinal fissure is visible even in the dorsal view), whereas in *Galemys* a more conspicuous development of the neocortex is observed, the rhinal fissure being invisible in the dorsal view and displaced to the rear. It seems possible to estimate the degree of development of the brain in the fossil forms by the position of this fissure. In this respect *Galemys pyrenaicus* approximates to *Neomys*, i. e., it shows a great expansion of the neocortex. *Desmana moschata*, which is better adapted for the aquatic mode of life than *Neomys* and *Galemys*, seems to have its sense of smell still more deficient and, when seeking after food, it is led mostly by touch. It is a well-known fact that it hardly ever leaves water, much unlike *Neomys*, which may often be met with far from any water reservoirs, or *Galemys pyrenaicus*, which regularly comes out of water by night in the summer and feeds in the meadows, often till daybreak.

In phylogeny water-moles show a clear-cut tendency toward adaptation for life in water and feeding on aquatic food, chiefly molluscs, in the place of insects gathered on land. Evidence of this is provided by the femur, which has changed considerably in the process of evolution becoming better and better adapted for the function of swimming, and the structure of the mandible and teeth, which have become bigger and more massive in course of time (TOPACHEVSKI, 1962). The latter is especially true of the first upper and second lower incisors, used to crush shells. It follows that Upper-Pliocene *Desmana kormosi*, having a weak femur and delicate mandibles and teeth, was probably a species which spent more time on land than in water and, consequently, had a better olfactory sense than the geologically younger fossil species and modern forms. Unfortunately, the question cannot be answered on the basis of the measurements of the cerebral olfactory centres alone.

The measurements of the brain of *Desmana kormosi* are much smaller than those of modern *Desmana moschata*. This agrees with the evolutionary tendency toward the enlargement of size in desmans. However, the proportions of the brain of *Desmana kormosi* more resemble the corresponding proportions of *Desmana moschata* than those of *Galemys pyrenaicus*, which supports the placement of this fossil form in the genus *Desmana* in spite of its small size.

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STRESZCZENIE

Praca zawiera opis kopalnego odlewu mózgu *Desmana kormosi* Schreuder 1940 z późnoplioceńskiego stanowiska fauny w Wężach koło Działoszyna. Jest to pierwszy opis mózgu kopalnego przedstawiciela podrodziny Desmaninae. Okaz porównano z mózgiem współczesnej *Galemys pyrenaicus* Geoffroy 1811 i ze sztucznym odlewem wnętrza puszki mózgowej *Desmana moschata* (L. 1758). Stwierdzono, że mózg *Desmana kormosi* miał wymiary zbliżone do *Galemys pyrenaicus*, proporcjami natomiast zbliżał się do *Desmana moschata*.

W kopalnym odlewie mózgu stwierdzono, że fissura rhinalis, będąca jedyną bruzdą, rysuje się pomiędzy opuszką węchową i lobus pyriformis a neocortex i ciągnie się w płaszczyźnie horyzontalnej. Opuszki węchowe są wyciągnięte ku przodowi. Cerebellum niewielkie w stosunku do wielkości półkul mózgowych i nie wychodzi poza ich długość. Bruzdy móżdżku są pojedyncze i nieliczne. Vermis cerebelli biegnie ku dołowi i nie kieruje się w tył. Rozmiary i proporcje kopalnego odlewu mózgu w porównaniu z formami współczesnymi podano w tabelach II i III.

РЕЗЮМЕ

Авторы описывают ископаемый отлив мозга *Dermana kormosi* Schreuder 1940 из верхне-плиоценского места находки фауны в Венжах около Дзялошина. Это первое описание мозга ископаемого представителя подсемейства Desmaninae. Экземпляр сравнено из мозгом современной *Galemys pyrenaicus* Geoffroy 1811, а также с искусственным отливом полости мозгового черепа *Desmana moschata* (L. 1758). Констатировано, что мозг *Desmana kormosi* имел размеры близкие к *Galemys pyrenaicus*, а пропорциями был похож к *Desmana moschata*.

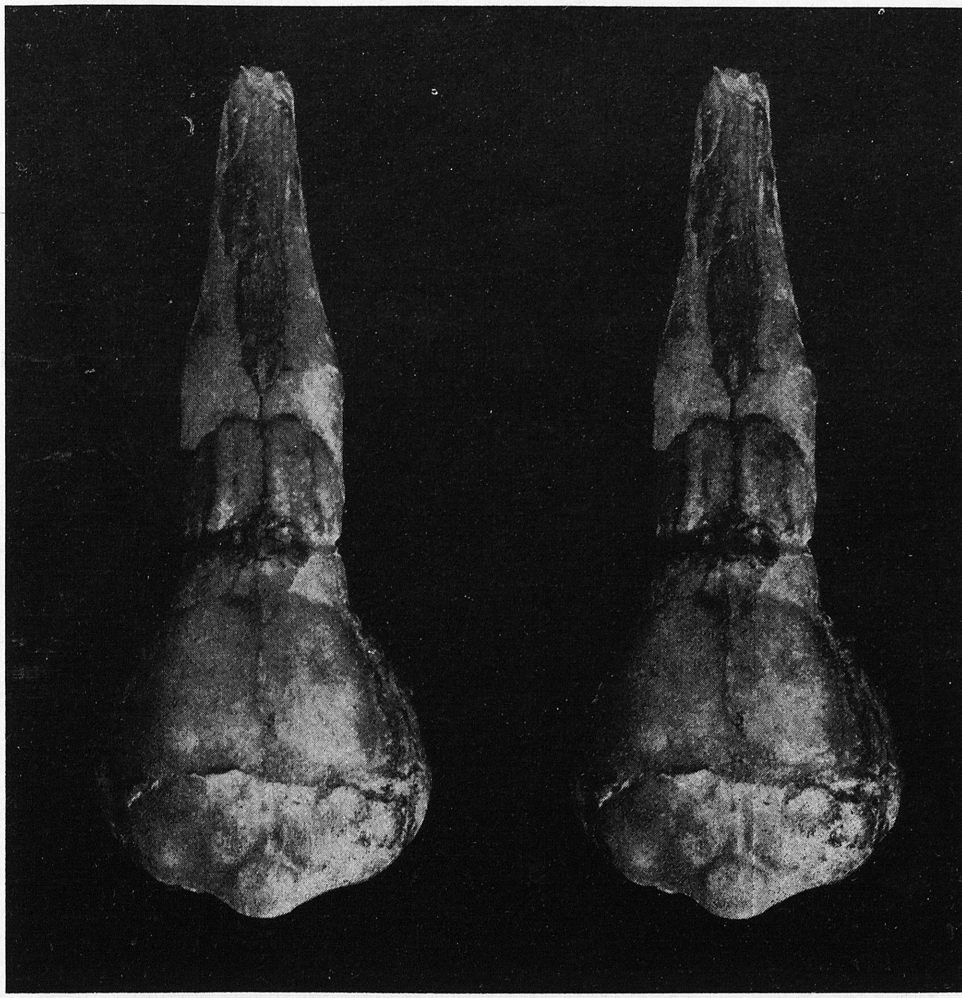
В ископаемом отливе мозга констатировано, что fissura rhinalis, являющаяся единственной бороздой проходит между обонятельной долькой и lobus pyriformis а также neocortex и тянется в горизонтальной плоскости. Обонятельные дольки вытянуты вперёд. Cerebellum небольшое в отношении к величине мозговых полушариев и не выходит за их длину. Борозды мозжечка одиночные и немногочисленные. Vermis cerebellum проходит вниз и не направлен к заду. Размеры и пропорции ископаемого отлива мозга в сравнении с современными видами представлено во II и III таблице.

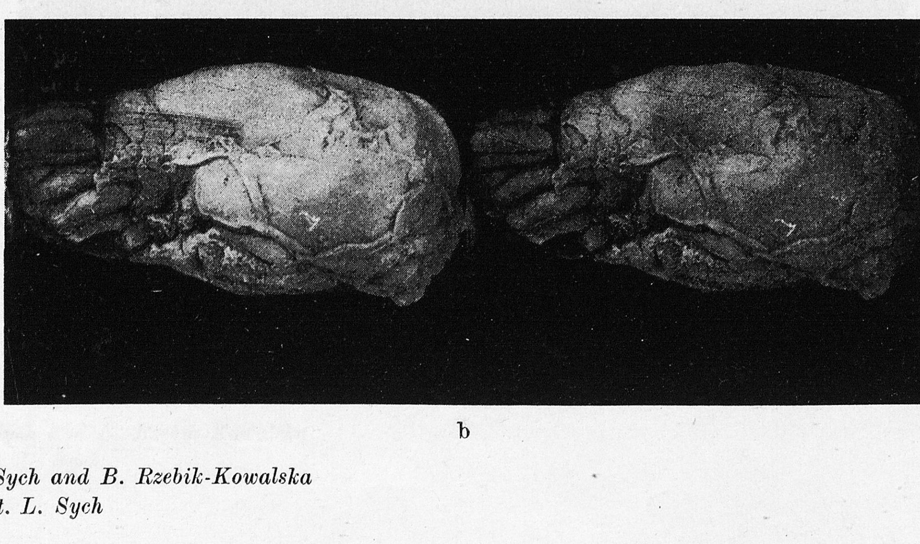
PLATES

Plate I

Stereopairs of the endocranial cast of *Desmana kormosi* from Węże. a — dorsal view, b — lateral view

a





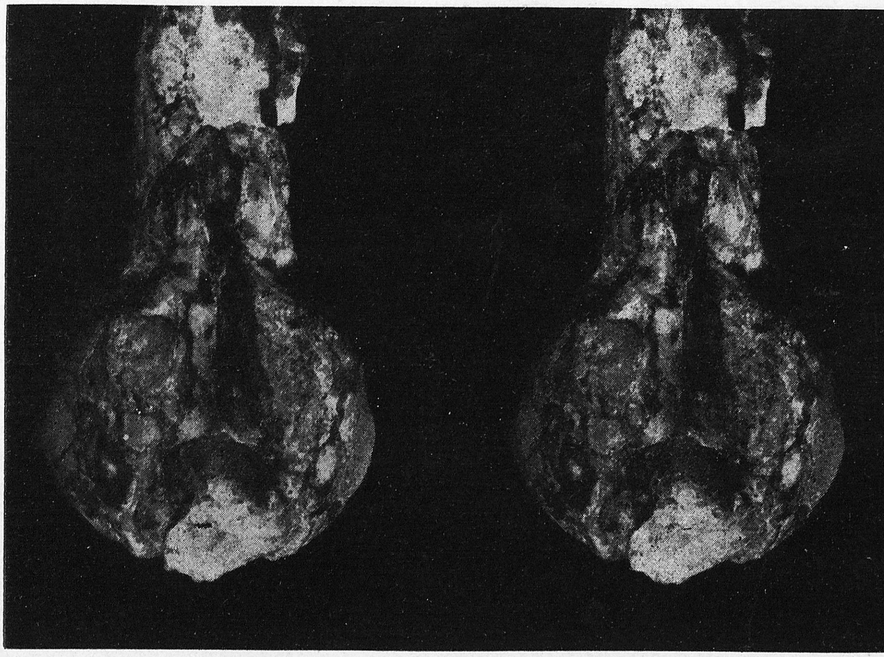
b

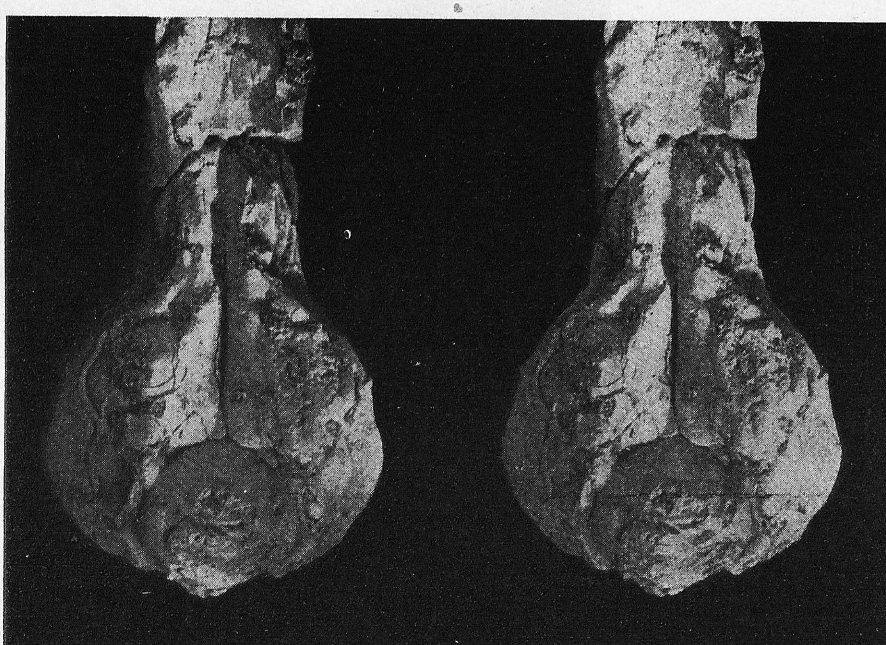
B. Sych and B. Rzebik-Kowalska
Phot. L. Sych

Plate II

Stereopairs of the fossil endocranial cast of *Desmana kormosi* from Węże, ventral view. a — with natural surface preserved, b — covered with ammonium chloride

a





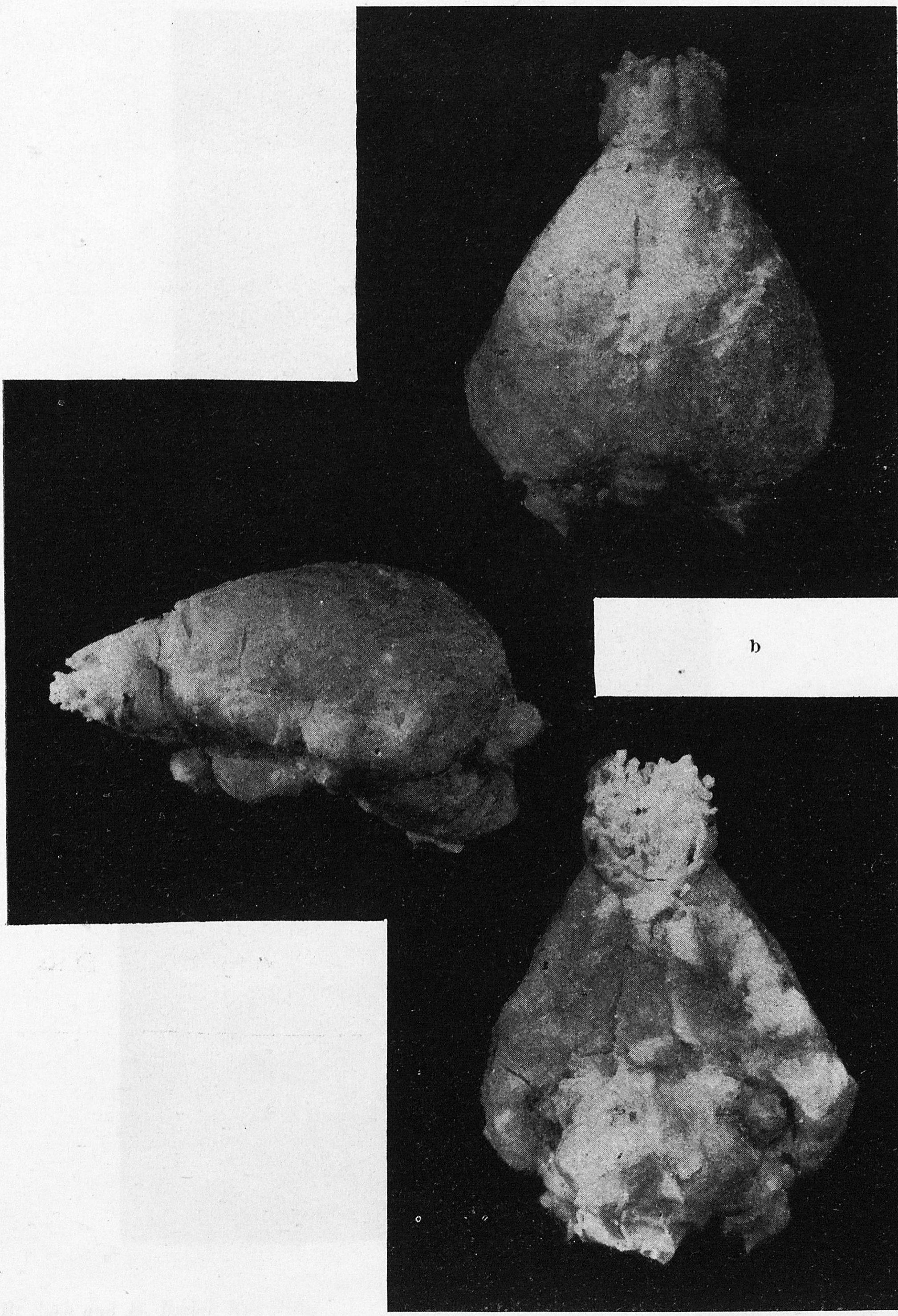
b

B. Sych and B. Rzebik-Kowalska
Phot. L. Sych

Plate III

Endocranial plastic cast of *Desmana moschata*. a — dorsal view, b — lateral view, c — ventral view

a



b

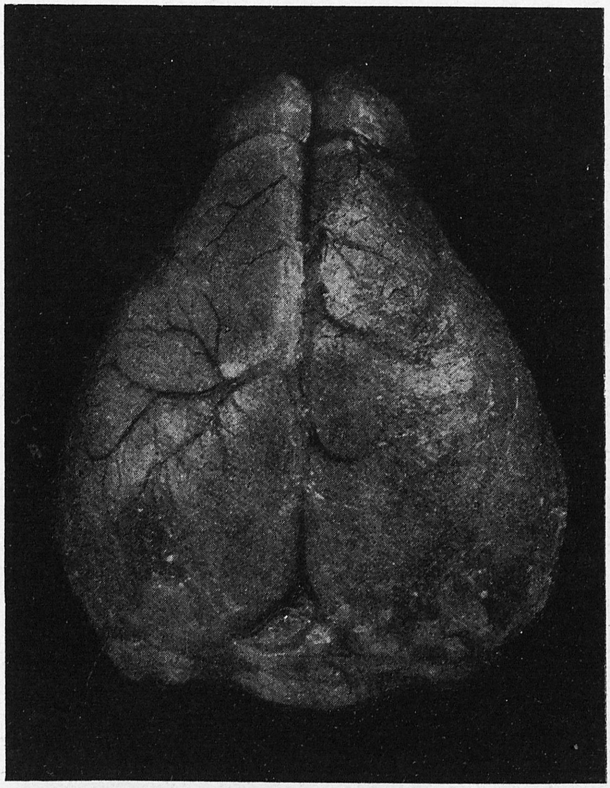
c

B. Sych and B. Rzebik-Kowalska
Phot. L. Sych

Plate IV

Brain of *Galemys pyrenaicus*. a — dorsal view, b — lateral view

a





b

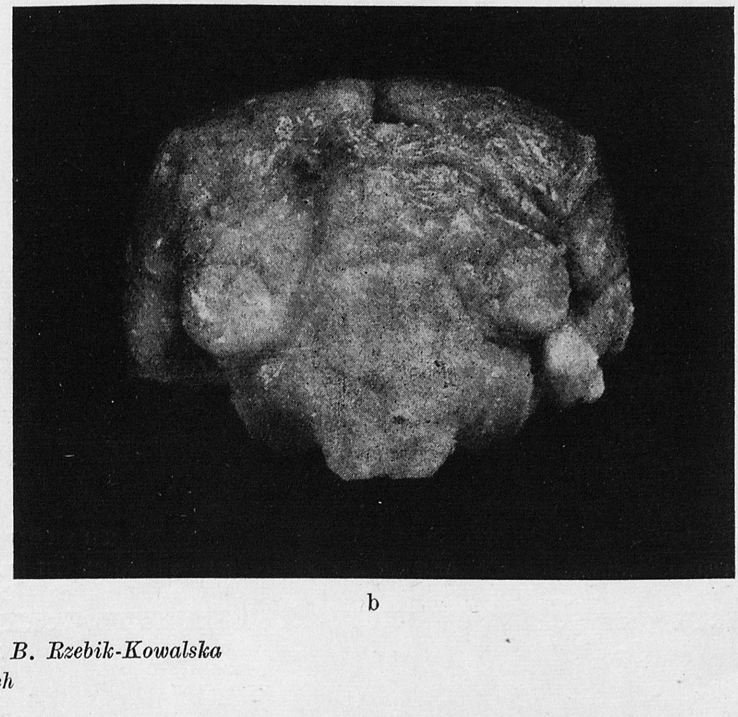
B. Sych and B. Rzebik-Kowalska
Phot. L. Sych

Plate V

Brain of *Galemys pyrenaicus*. a — ventral view, b — caudal view

a





b

B. Sych and B. Rzebik-Kowalska
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